

COLLEGE MATHEMATICS FOR NON-SCIENCE STUDENTS

A report of the Special Committee on College Mathematics for Non-Science Students, a Subcommittee of the California Committee for the Study of Education.

This committee has undertaken a study of College Mathematics for General Education, defined as that mathematics which is studied in the freshman or sophomore year as part of a liberal education. It is not a course planned for engineers, professional mathematicians, physical or biological scientists, or even for the modern social scientist who needs specialized mathematics peculiar to his field of research.

I. Current Practices in the Field of College Mathematics for General Education

In order to gain a knowledge of current practices in this field as to curricula, related teaching problems and their solutions, questionnaires were sent to about 250 representative colleges throughout United States and Canada.

Of 110 colleges making replies on the questionnaires, 67 were offering special courses in mathematics for non-science majors, 16 expressed a desire to give such courses, although at present they did not do so. The remaining 27 implied that the usual sequence of mathematics courses was adequate for all of their students.

Most colleges reported that the students who took these special courses had two years of high school mathematics, but in many schools the students had less preparatory mathematics and in a few they had more.

Thirty-three different textbooks were being used, and in six colleges instructors used their own manuscripts. The books used most frequently by those replying on the questionnaires were the textbooks by Richardson; Newsom and Eves; Leonhardy; Cooley, Gans, Kline and Wahlert; Trimble, Peck, Bolser; Jones; Griffin. Relatively few instructors were completely satisfied with any available text indicating that there is essentially no agreement on the topics to be included in a course in mathematics for general education.

Colleges devoted different amounts of time and credit to the course, varying from two to ten semester units. The majority offered either a one semester three credit course or a two semester course, three units each semester. These were in about equal numbers. Most of these courses were required, or they met a general college requirement that could also be satisfied in some other way.

The nature of the course varied greatly in different institutions. In some of the large state universities where they were obliged to take students with little or no high school mathematics, the presence of poor students, large classes and inexperienced teachers made their courses chiefly basic skills courses with emphasis on computation and techniques. They were unhappy about the situation and saw the need for improvement.

In most colleges these courses in mathematics for general education used a historical, intuitive and cultural approach with emphasis on ideas rather than on manipulation or computation. There was a wide range of difficulty. It varied from courses planned for students with no high school mathematical preparation to courses on a high level which emphasized modern mathematics and tried to encourage thinking of an original nature.

Problem solving was the chief type of homework for these courses, but essays and oral reports were frequently required. Practically all organized course activity was limited to the classroom, with few field trips.

The questionnaires also sought information concerning the attitudes of the students, their emotional reactions, what topics they liked most and what they liked least. The replies on these questions were difficult to tabulate, but they indicated (1) that a large proportion of the students who took these courses had had some unfortunate mathematical experience which frequently left them with a negative attitude toward mathematics; and (2) that there is some agreement on topics which inspire enthusiasm and those which antagonize.

The following were mentioned as experiences which caused most enthusiasm: applications; bizarre, new or unusual results; modern implications; problems which can be visualized; problems which the student can solve; challenging situations; discovery on one's own; reasoning; elementary logic; number scales; higher dimensions; transfinite numbers; maximum and minimum problems; problems involving rates; learning how to read stated problems; variation problems; percentage; applications in the field of business; annuities; graphs; statistics and probability; starting at the student's level of understanding and enabling him to achieve success.

Among experiences which seemed to antagonize students the following were mentioned: new definitions; difficult ideas with no applications; not obviously useful or necessary abstractions; logic; topology; proofs, especially detailed tricky proofs; abstract geometry; formal algebra; word problems; lengthy computations; having to give reasons; careful reasoning; thinking; routine.

From an overall examination of the replies on the questionnaires the following generalizations may be drawn:

(1) There is not a single course that meets the needs of all students and all instructors. Successful courses are taught at different levels of mathematical difficulty and maturity.

(2) It is just as important to consider the instructor as it is the students in preparing a course.

(3) The choice of topics is not as important for the success of the course as are the attitude and interests of the teacher, and the attitudes and emotions of the students.

II. Textbooks and Literature on Mathematics for General Education

Much has been published in recent years on the subject of mathematics for general education. The committee has compiled a limited annotated bibliog-

raphy of some textbooks and articles from leading journals which are pertinent to the subject of this study. Copies of this bibliography may be obtained by writing to Professor May M. Beenken, Immaculate Heart College, 2021 North Western Avenue, Los Angeles 27, California.

III. Committee Recommendations

The committee does not recommend a single course to meet the needs of all students and all instructors. Successful courses may be constructed for students of different degrees of mathematical maturity.

The following are guiding principles to consider in constructing a course in mathematics for general education. It should include mathematics that is useful in the home, business and everyday occupations, mathematics which the student will use in other college courses and the mathematics which throws light on the culture of our society. The course should be taught with an adult approach, from a mature and reasonable point of view.

Emphasis in this course will be on critical thinking and understanding rather than technique. But since real understanding must come through application of principles, it must be a course in mathematics and not just about mathematics. Appeal will be made through the beauty of mathematics as well as its utility.

Students who take mathematics for general education are frequently those who have emotional blocks toward the study of mathematics. It will then be not so much the content as the attitude and teaching approach that must distinguish this course from other courses in mathematics. We must meet students where they are and lead them along the path of mathematics as a meaningful aid in precise thinking. This course requires a teacher who is interested in helping students to overcome their blocks and to acquire a liking for mathematics and a feeling of confidence in their ability to do mathematics. The teacher should have a thorough knowledge of mathematical theory and a wide acquaintance with applications to the arts and sciences. He should be well versed in the history of mathematics and its cultural significance. Further qualifications of the successful teacher are patience and an understanding of the learning process.

Beyond such essential topics as the number system, operations with numbers, arithmetic of measurement, functions, graphs, equations and formulas, logical reasoning, the selection of topics should be influenced by the desires and abilities of the students, the interests of the teacher, and the amount of available time. Other topics which may be included are introduction to the calculus, probability and statistics, number theory and some elementary aspects of modern mathematics. In this work the objective will be more an attitude or point of view than a definite amount of knowledge or skill. Some history of mathematics, of important mathematical concepts and the role of mathematics in a world of scientific achievement should be interspersed throughout the entire course.

Upon completion of the course the student should be more critical and exact in his thinking, be better able to meet quantitative situations that arise in everyday living, and he should have a wholesome respect for the power and beauty of

mathematics as a living subject that is constantly growing to meet the needs of an advancing civilization.

A standard course in mathematics for general education should carry three units of credit for each of two semesters. Some colleges may wish to devote more time and credit to this course; others may be restricted to less. Since the success of the course in any college requires the support of all members of the faculty and administration, a major effort should be made to enlist their cooperation through an adequate interpretation of the course to them.

IV. Universal Mathematics

A committee of the Mathematical Association of America on the Undergraduate Mathematical Program has made a thorough study, and advocates a universal freshman course. A first effort at writing a text for such a course has been published as *Universal Mathematics* by the 1954 Summer Writing Group of the University of Kansas.

Universal Mathematics requires a higher level of mathematical preparation than is assumed for the course discussed in this report. This committee urges college mathematics teachers to read the reports of the Committee on the Undergraduate Mathematics Program, and to experiment with the ideas suggested. We agree that students interested in technical mathematics, whether for natural science, social science or the arts, might well take the same course, which should be different from the traditional course. But this is not the class of students for whom a course in mathematics for general education, as defined in this report, is designed.

We feel that it would be inadvisable to give the technically able students, with superior mathematical background of high school mathematics, the same course as average liberal arts students pursuing non-scientific courses, who have had little training in secondary mathematics.

Acknowledgments

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This report was presented April 20, 1956 by Committee:

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